

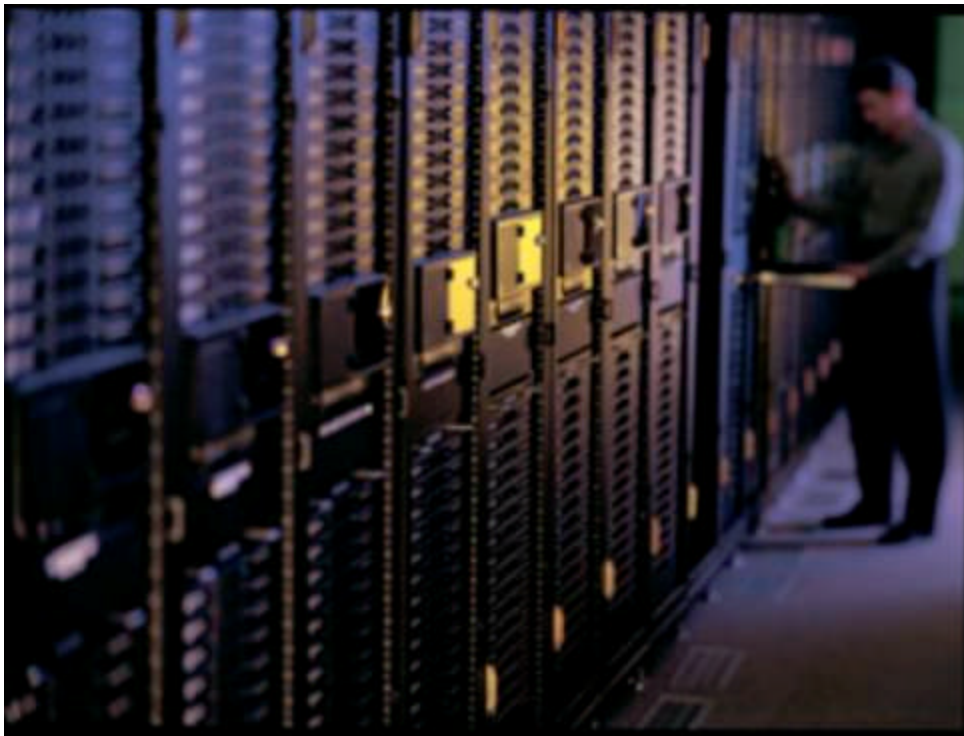
AMD High Performance Computing – AMD Opteron™ Processor

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Sep. 6, 2003
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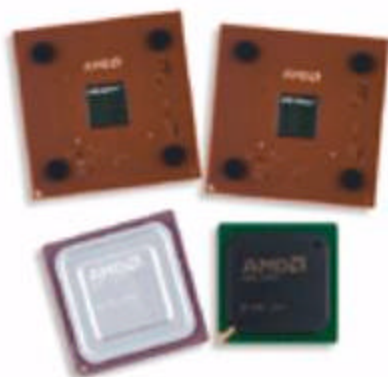
- AMD Server Processor
- AMD Opteron™ Processor Overview
- AMD Opteron™ Processor Benchmarks
- AMD64 Software
- Summary



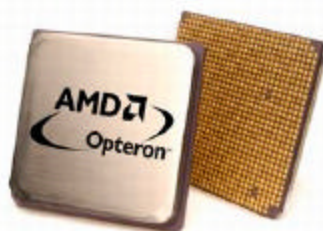
AMD 

AMD Server Processor

Server/Workstation Milestones



- **June 2001** - Entered the Server/Workstation Market with introduction of Athlon MP and AMD-760™
- **October 2001** - Launched AMD Athlon™ MP processor 1800+, 1600+, 1500+
- **December 2001** - Launched AMD Athlon™ MP processor 1900+ and the 760-MPX Chipset; Motherboard support expanded to 5
- **February 2002** – First public demonstrations of x86-64 8th Generation processor – running in compatibility mode, and 32 bit mode
- **March 2002** – Launched AMD Athlon™ MP processor 2000+
- **April 2002** – AMD announces the AMD Opteron™ brand for multi processor Workstations and Servers



And
Gained Microsoft support to incorporate 64-bit support for the future 8th-generation AMD Athlon™ and AMD Opteron™ processors into the Windows® operating system

And
Publicly displayed AMD Opteron dual processor-based server running a developmental 64-bit version of Windows at the annual shareholders' meeting

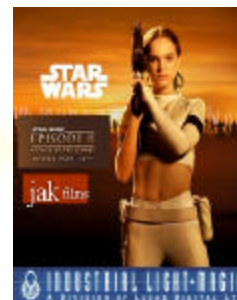
- **June 2002** – AMD demos first 4-way Opteron based server at Computex
- **April 2003** – AMD Launch Opteron Processor



AMD Athlon™ processors in use...



Rhythm & Hues employed 42 dual processor-based Angstrom Microsystems servers running **AMD Athlon™** processors in its render farm.

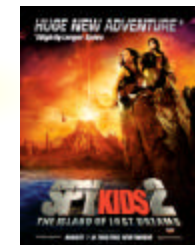


Pre-visualization by JAK Films and post-production by **Industrial Light & Magic** used systems powered by **AMD Athlon™ MP** processors. Used in **Star Wars – Episode II**



Boeing selected AMD processors to power a 96-node **AMD Athlon™** super-cluster to support its **Delta IV** program. Cluster used to simulate aerodynamic performance of rocket family.

AMD Athlon™ MP processors power creativity in **Spy Kids 2: The Island of Lost Dreams**



Electronic Arts to use AMD Athlon™ processor-based systems **worldwide**



Mercedes-Benz Technology Center (MTC) in Germany utilizes a cluster based on **AMD Athlon** processors to do crash simulation analysis on its vehicles.



Veritas Geophysical is processing high-resolution seismic data with **AMD Athlon™** processor-based Racksaver Cluster that provides an incredible amount of computing power under one roof.

Some of the **most powerful** computers **in the world** today – driven by AMD!



Top 500 Supercomputing List (as of November 2002)



68th with 480 processor system running **AMD Athlon** processors

UC SANTA CRUZ

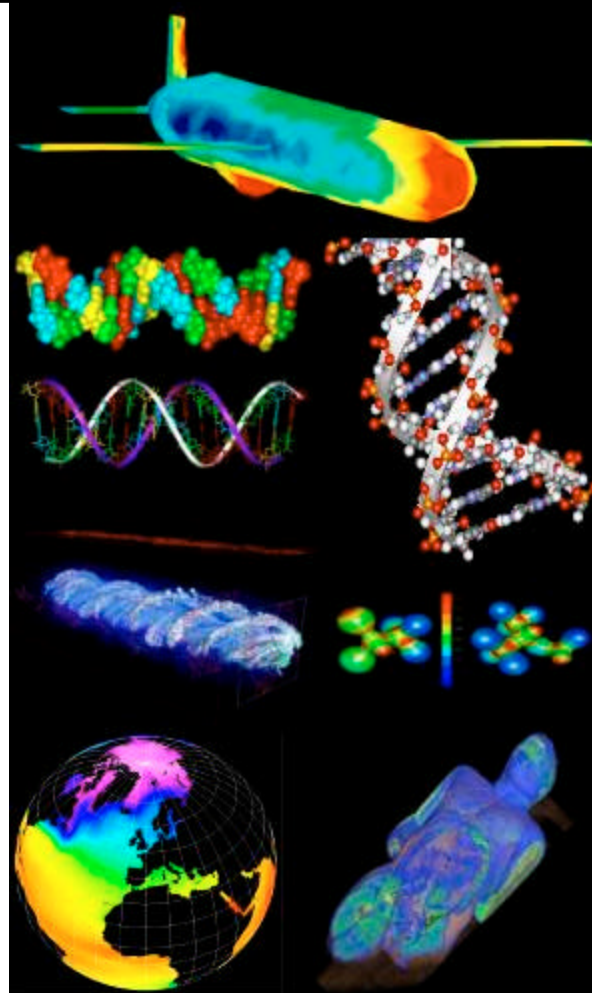
215rd with 264 processor Racksaver system running **AMD Athlon** processors



304th – Helix, a Megware system with 132 **AMD Athlon** processors



64th with 256 dual processor nodes running **AMD Athlon** processors



UMEA University
HPC2N Super Cluster
124th with 120 dual processors nodes running **AMD Athlon** processors



University of Bochum
302nd – MegWare System with 128 **AMD Athlon** processors



University of Vienna
370th – Schroedinger I, a self-made system with 160 **AMD Athlon** processors



139th – Prairiefire, a Atipa Technology system with 246 **AMD Athlon** processors

The AMD Opteron™ processor

Project "Red Storm"



Sandia
National
Laboratories



- ✓ Cray will build a 40+ teraflop super computer using x86-64 AMD Opteron™ processors for Sandia National Laboratories

- ✓ Will be used for advanced engineering simulations

- ✓ \$90 million project will use more than 10,000 AMD Opteron™ processors

- ✓ Will feature a simple building block approach with HyperTransport™ technology that will enable easy implementation and reduce engineering, design, and component costs



The AMD Opteron™ processor

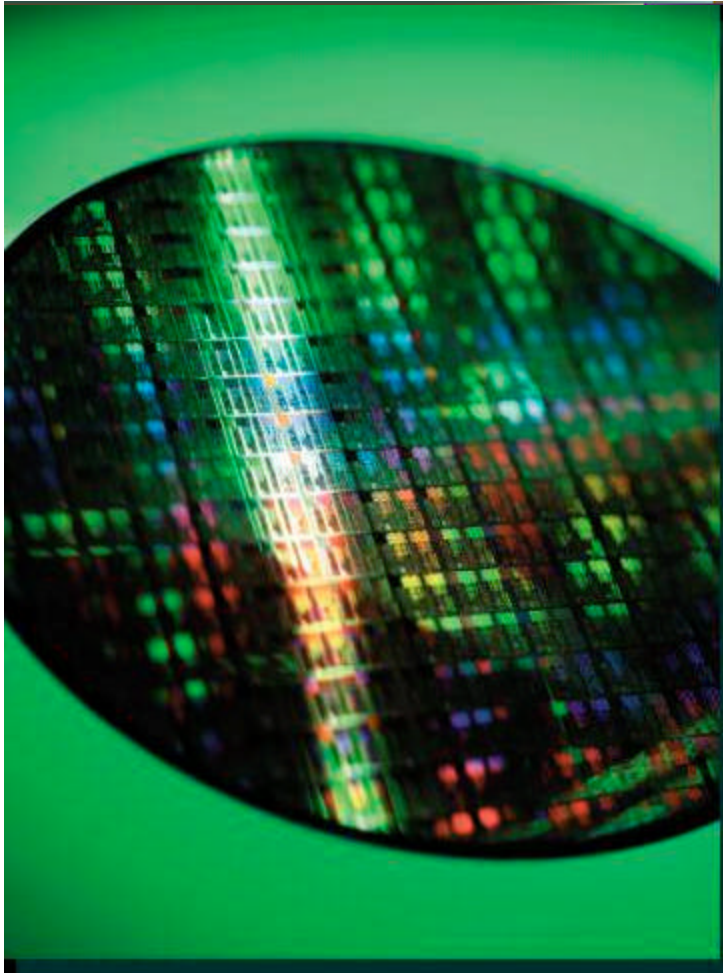
Design win Project



✓ **Los Alamos National Laboratory (8/14/2003)**

- ✓ two separate large-scale Linux clusters. More than 3,300 AMD Opteron processors
- ✓ medical, environmental and national defense modeling and simulation.
- ✓ Both the Lightning and Orange clusters are being designed, built and integrated for Los Alamos National Laboratory by LinuxNetworkx and will be powered by the AMD Opteron processor Model 244.

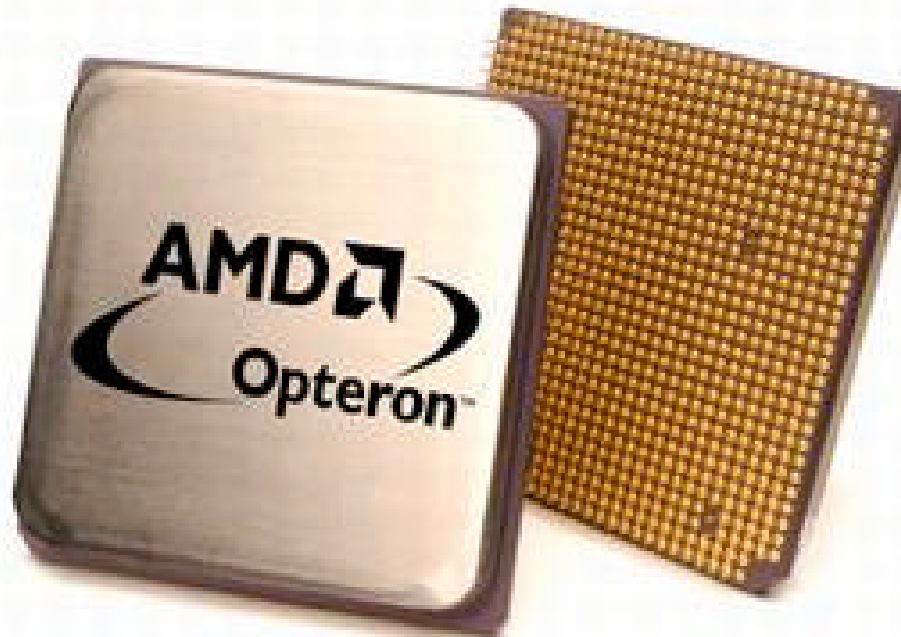
✓ **AMD Opteron™ Processors Power Linux World Conference's Best Cluster Solution: the IBM DB2 Integrated Cluster Environment (8/07/2003)**



AMD Opteron™ Processor Overview

AMD Opteron™ Processor

- 940 Pin



Three AMD Opteron™ Devices



High-end Server
4P to 8P

**AMD Opteron™
800 Series**
Up to 8 way

Clock	Model
1.4GHz	840
1.6GHz	842
1.8GHz	844
:	:

Workstation and
Mid-range Server
2P

**AMD Opteron™
200 Series**
Up to 2 way

Clock	Model
1.4GHz	240
1.6GHz	242
1.8GHz	244
:	:

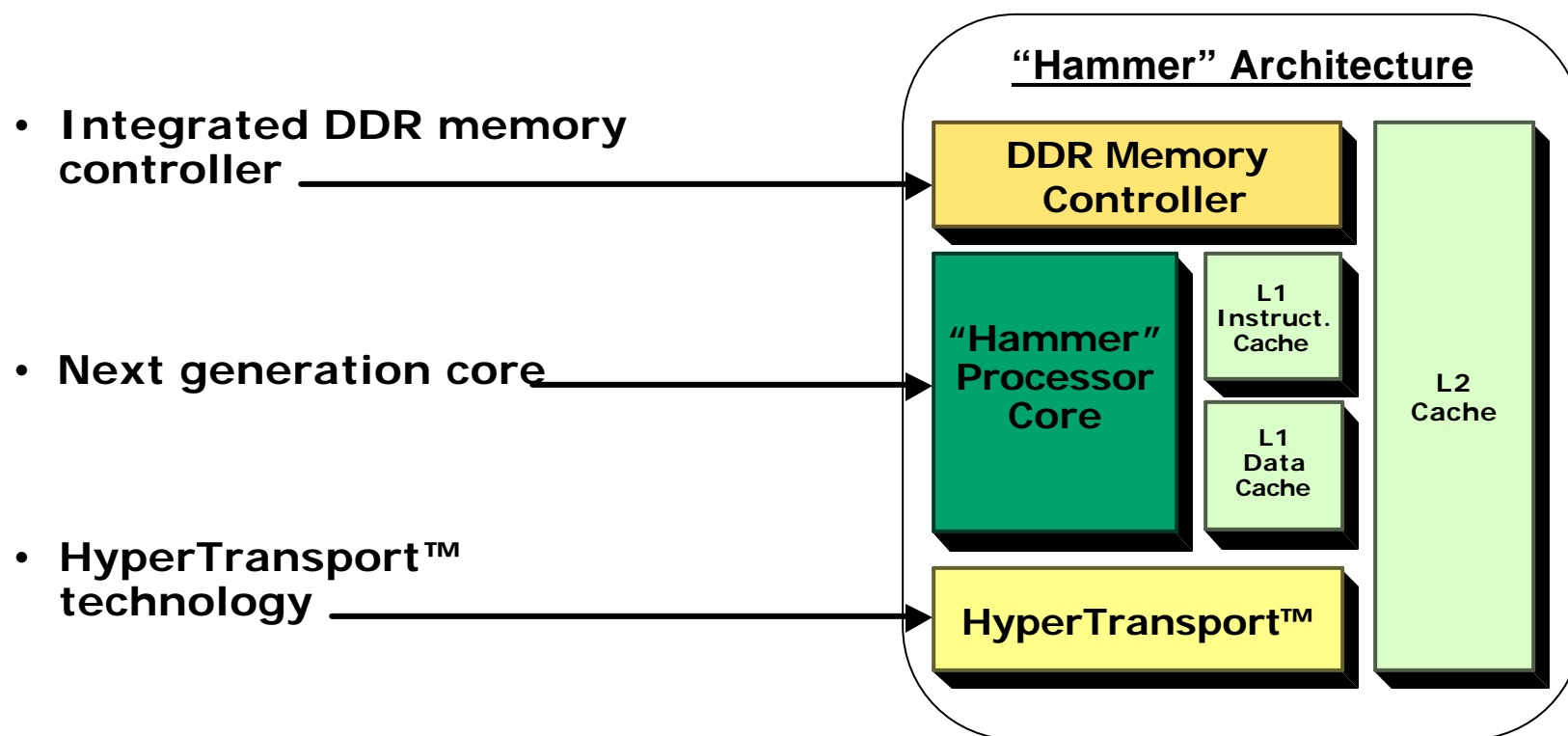
Value Server
1P

**AMD Opteron™
100 Series**
1 way

Clock	Model
1.6GHz	142
1.8GHz	144
:	:

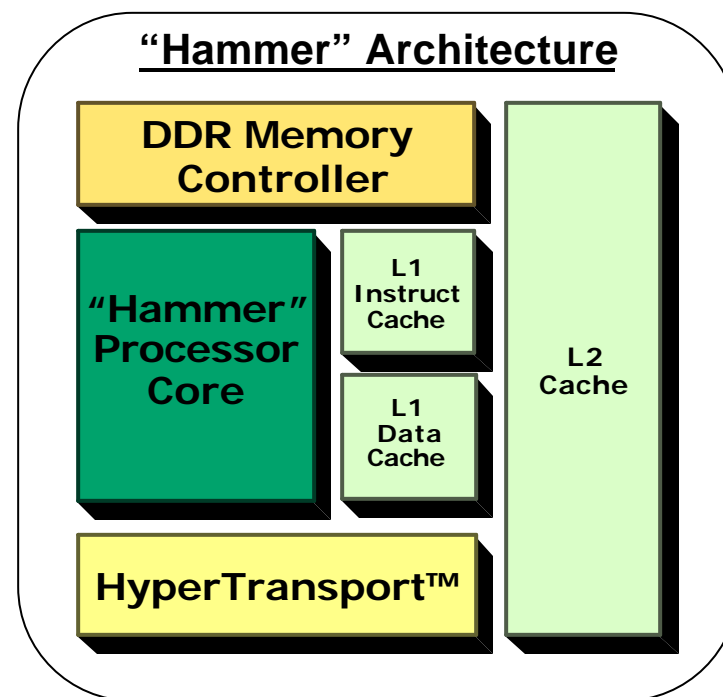
Key Architecture Innovations

- AMD's next-generation "Hammer" architecture integrates key system elements:



"Hammer" Processor Core

- What is AMD's next-generation processor core?
 - AMD's latest processor innovation, which is designed to support both 64-bit and 32-bit computing at exceptional performance levels
 - Processor core details
 - Support for x86-64 technology
 - 12-stage superscalar pipeline
 - Big workload features
 - Enlarged 2-level TLB
 - TLB flush filter
 - Enhanced branch prediction
 - Large caches
 - Reliability features
 - ECC protection on large arrays
 - Parity protection on major busses
- What does it do?
 - Designed to provide high performance & high throughput on both 32-bit and 64-bit computing applications
 - Planned to provide computational reliability



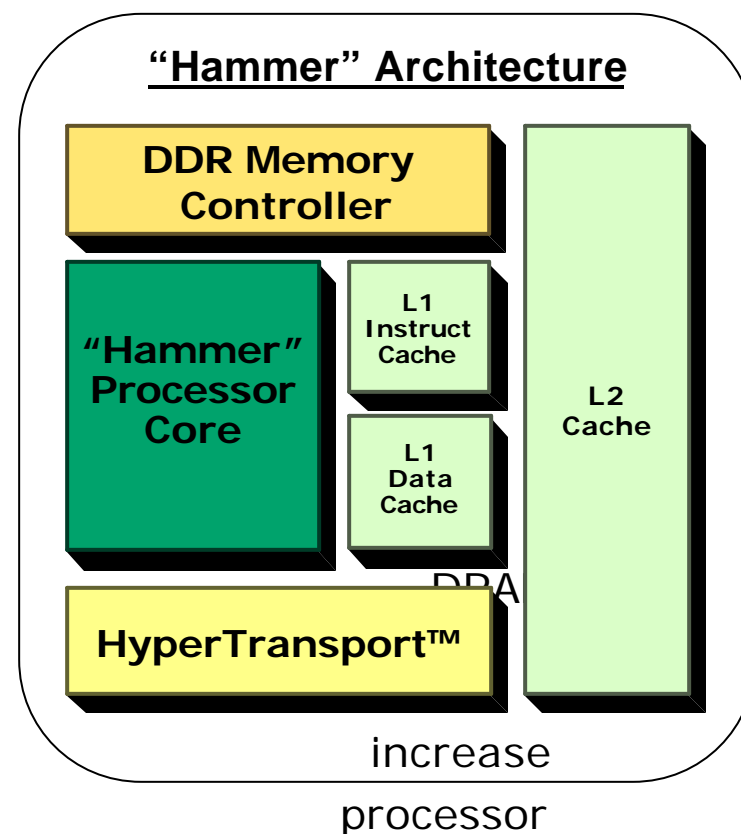
Integrated Memory Controller

- **What is an Integrated Memory Controller?**

- Integration of memory controller functionality into the processor, traditionally a function of the northbridge
- DDR memory controller details
 - Single or dual channel DDR memory interface
 - Registered or Unbuffered DIMMs
 - Support for PC1600, PC2100, or PC2700 DDR SDRAM
 - Full ECC & Chip Kill for reliability
 - High bandwidth (up to 5.3GB/s)

- **What does it do?**

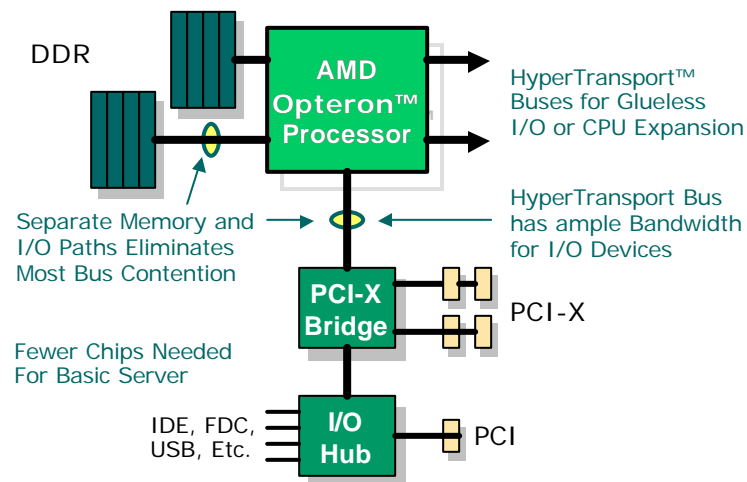
- Designed to dramatically reduce latency
- Memory bandwidth and capacity scales as the number of CPUs
- Memory controller operates at frequency (1:1 scaling)



Advanced AMD Opteron™ Processor System Architecture

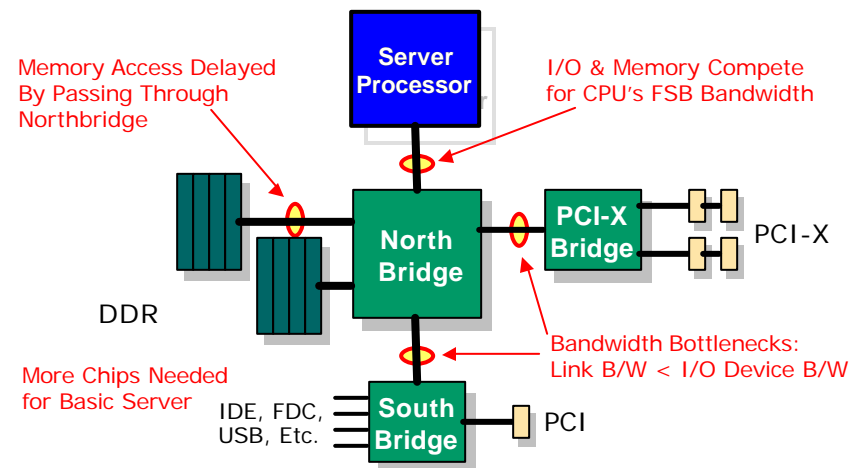


AMD64 System



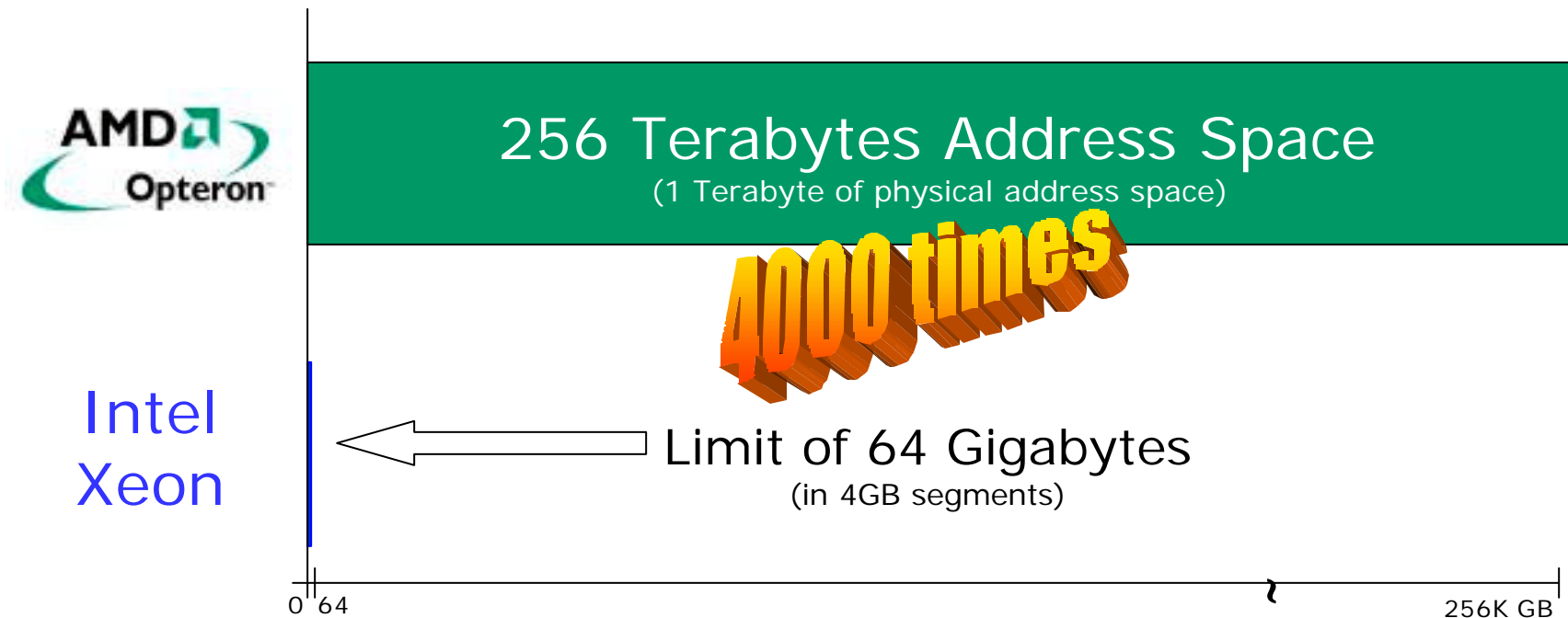
- Integrated memory controller
 - Low latency memory access speeds processing
- Separate Memory and I/O pathways
 - Eliminates I/O and memory bus competition
- Each processor has more memory & I/O paths
 - Memory and I/O bandwidth scales well
- Modular glueless logic using HyperTransport™ bus
 - Fewer chips and lower cost implementation

Typical System



- Must access memory through Northbridge
 - Longer latency memory access
- Memory and I/O access on the same bus
 - I/O and Memory compete for bandwidth
- Memory or I/O paths originate from Northbridge
 - Bandwidth does not scale well with more CPUs
- System logic uses more chips and many buses
 - Systems cost more to design, build and test

AMD's Larger Memory Address Space

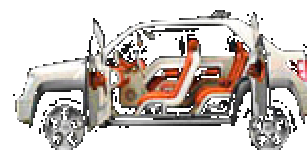


AMD's Opteron has orders of magnitude more memory address space, offering a significant performance benefit for applications where large datasets or many datasets (e.g., virtual machines) are held in memory

Busting out of the 4GB Limit

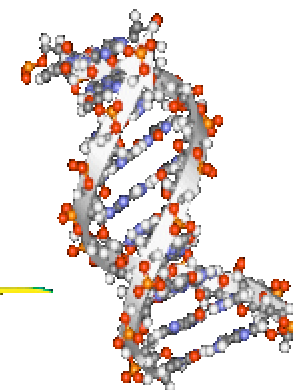
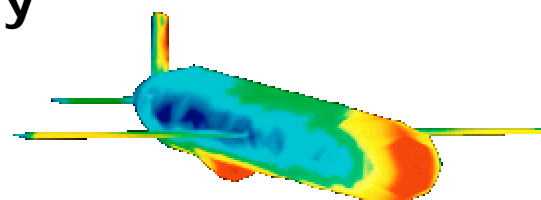
Applications that need improved performance

- 3D Graphics, CAD, CAM, and CAE (client)
- Video editing (client)
- Games (client & server)
- Searching/indexing (client & server)
- Rendering Engines (client & server)
- Streaming Media Engines (client & server)



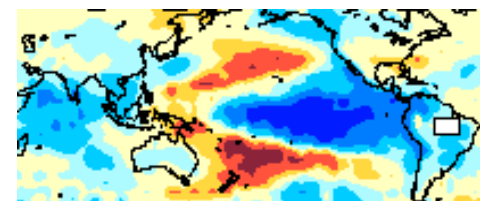
Applications that need large memory addressing

- Large data sets (client & server)
- Financial modeling (client & server)
- Scientific applications (client & server)
- Host-based desktop applications (server)
- Running multiple instances of applications simultaneously (server)



Applications that serve many transactions/users

- Database Engines (server)
- Web Servers (server)
- Email Servers (server)



HyperTransport™ Technology

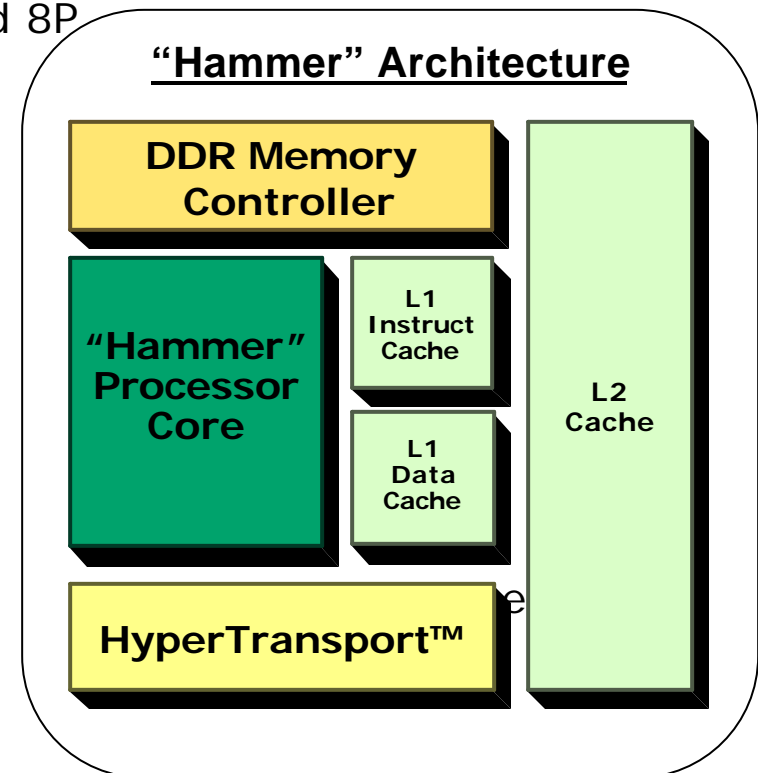


- **What is HyperTransport™ Technology?**

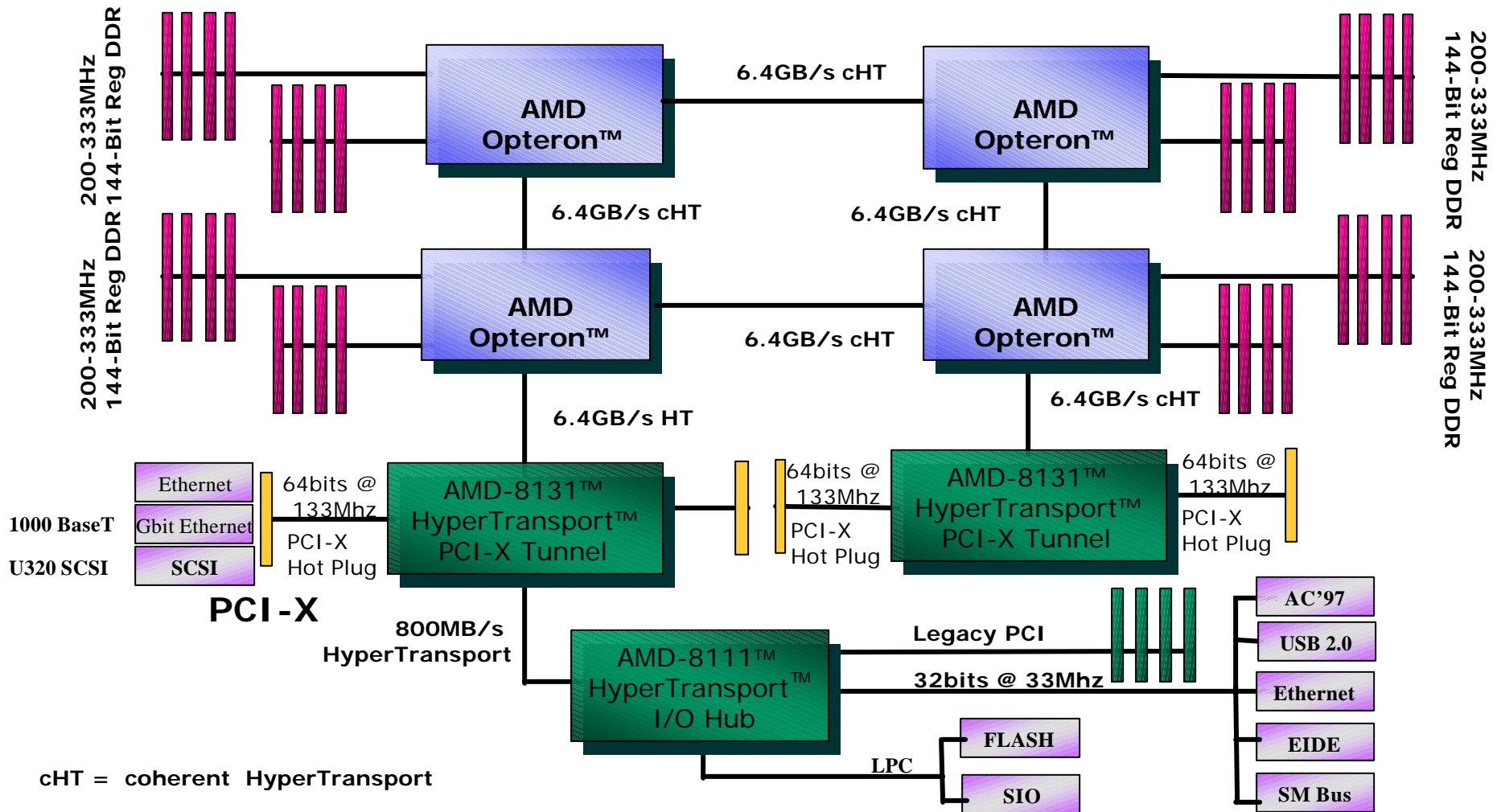
- HyperTransport technology is a high-speed, low pin-count, asynchronous, point-to-point link connecting chips
- Highly scalable to support 1P, 2P, 4P, and 8P multiprocessing system architectures
- Flexible
 - One, two, or three links
 - 2, 4, 8, 16, or 32-bits full duplex
- High bandwidth
 - Up to 6.4 GB/s bandwidth per link
 - 19.2 GB/s aggregate bandwidth
- In production today

- **What does it do?**

- Designed to increase overall by:
 - Removing I/O bottlenecks
 - Increasing bandwidth
 - Reducing latency
- Enables glueless multiprocessing
- Easy building-block approach to system design

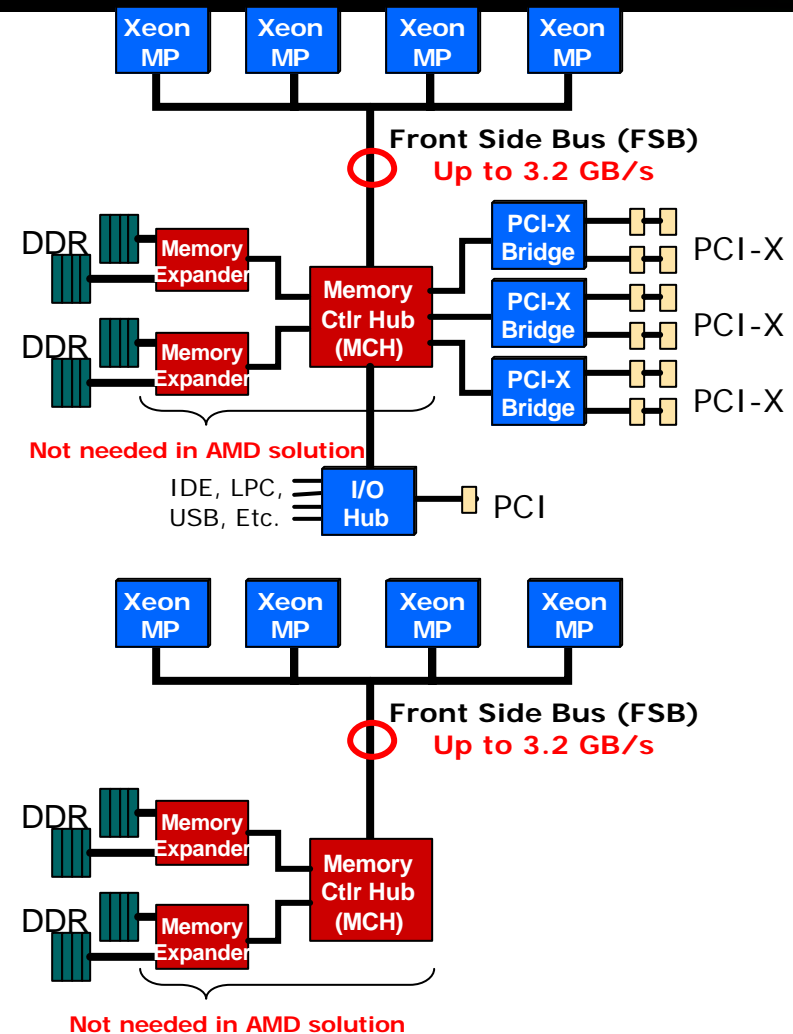
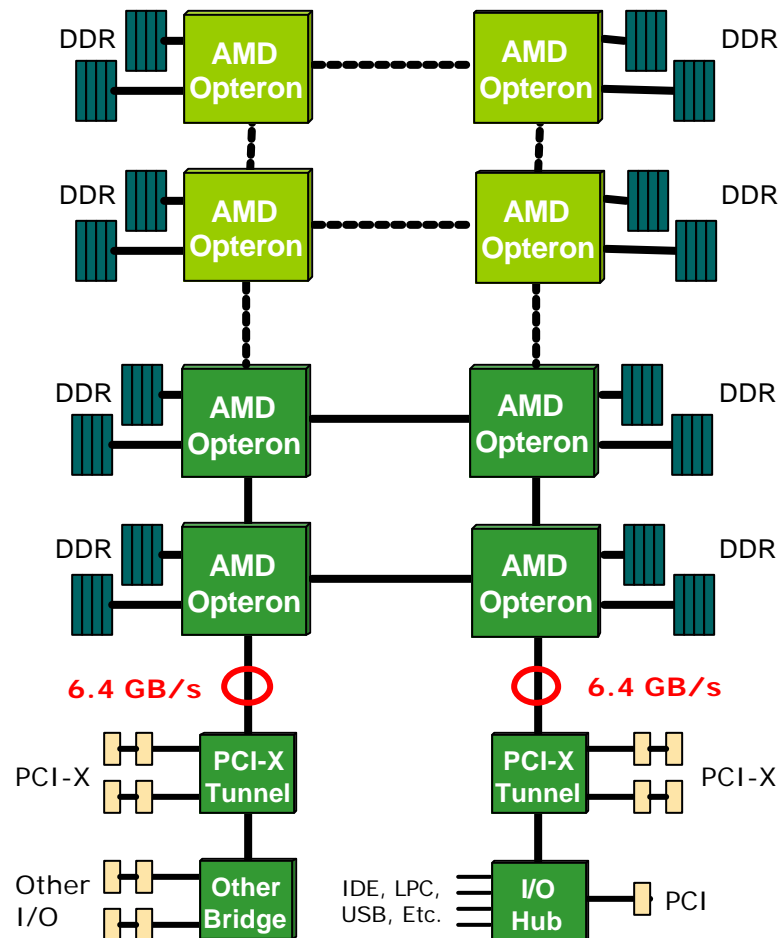


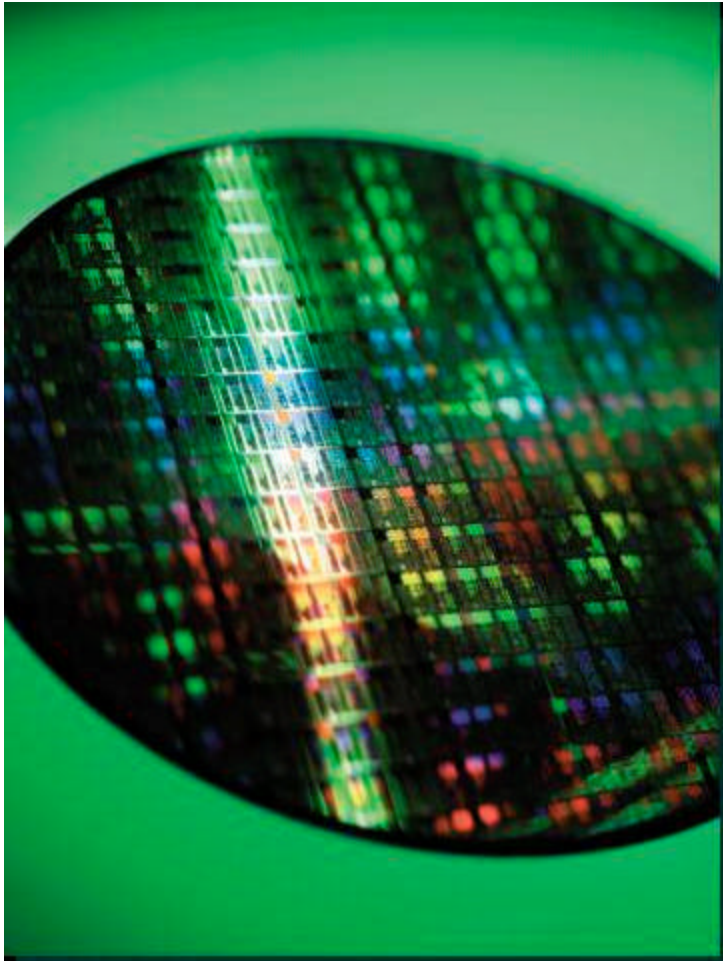
4P Server Implementation Example



Opteron™ System Architecture

Glueless Multiprocessing: 8P System Example



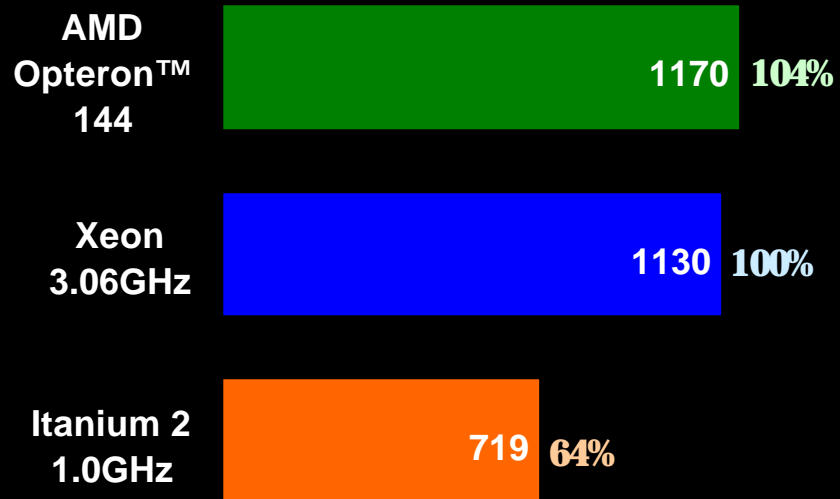


AMD Opteron™ Processor Benchmarks

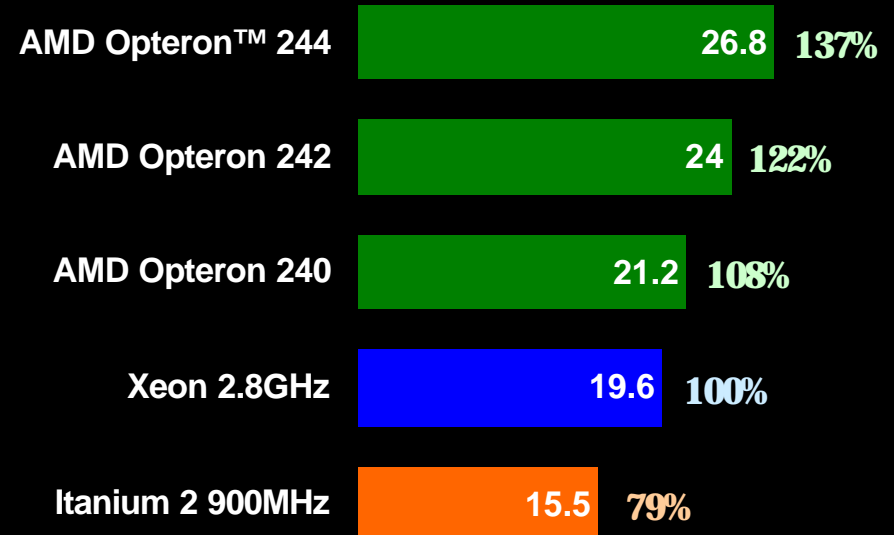


Integer Performance

SPECint®_peak2000 Performance (Uniprocessor)



SPECint®_rate2000 Performance (Peak, 2P)



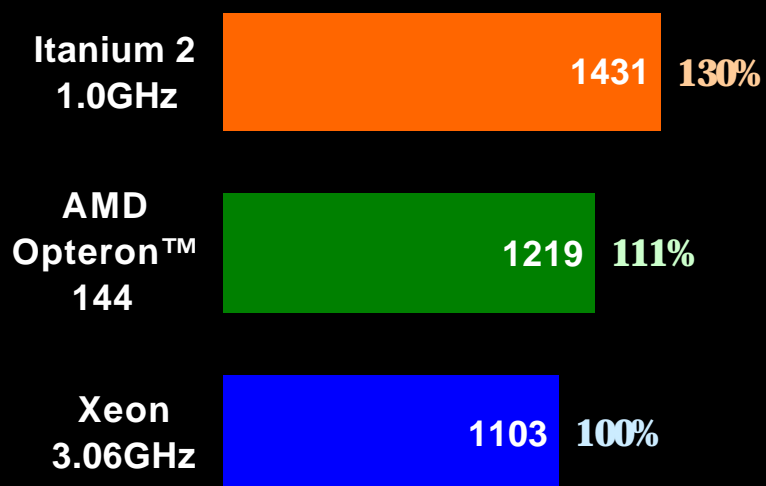
www.amd.com/opteronperformance

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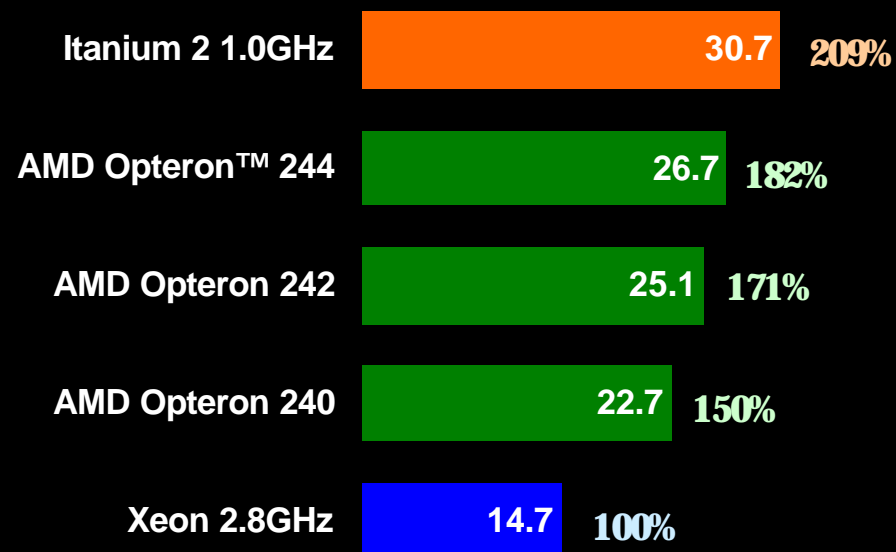


Floating-Point Performance

SPECfp®_peak2000 Performance (Uniprocessor)



SPECfp®_rate2000 Performance (Peak, 2P)



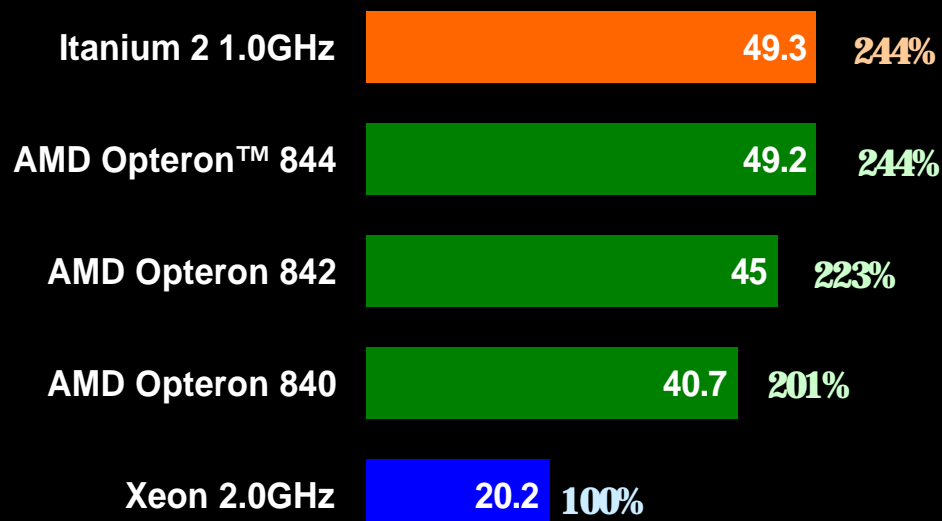
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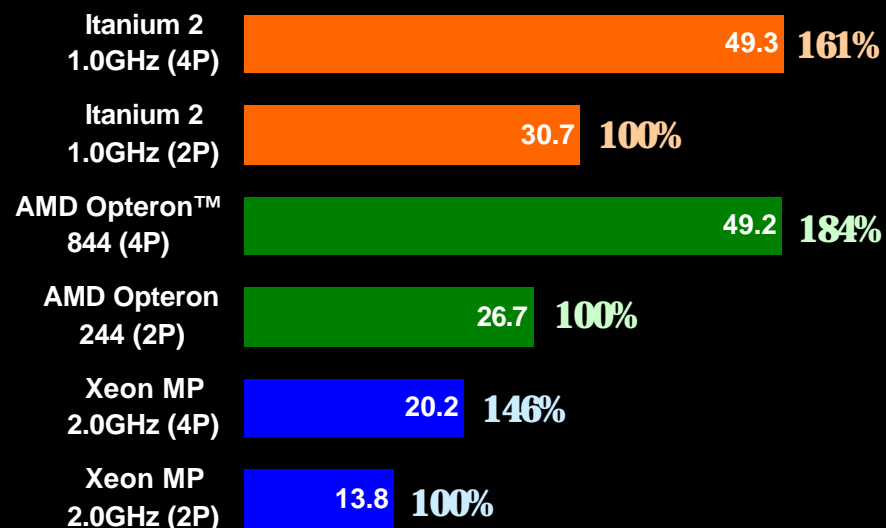


Floating-Point Performance

SPECfp®_rate2000 Performance (Peak, 4P)



SPECfp®_rate2000 Performance and Scalability (Peak, 2-4P scaling)



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Web Server Performance

SPECweb®99 Performance (2P Servers, Red Hat CA2)

AMD Opteron™ 244 6250 116%

AMD Opteron 242 5800 108%

Xeon
3.06 GHz 5373 100%

AMD Opteron 240 5181 96%

Itanium 2 N/A

SPECweb®99 Performance (4P Servers, Red Hat CA2)

AMD Opteron™ 844 10135 151%

AMD Opteron 842 9396 140%

AMD Opteron 840 8800 131%

Xeon MP
2.0 GHz 6700 100%

Itanium 2 N/A

www.amd.com/opteronperformance

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Secure Web Server Performance

SPECweb®99_ssl Performance (2P Servers)

AMD Opteron™ 244 (64-bit app/64-bit OS)	1783	155%
AMD Opteron 244 (32-bit app/32-bit OS)	1760	153%
Itanium 2 1.5GHz (64-bit app/64-bit OS)	1750	152%
Xeon 2.8GHz (32-bit app/32-bit OS)	1149	100%

SPECweb®99_ssl Performance (4P Servers)

AMD Opteron™ 844 (64-bit app/64-bit OS)	3498	213%
Itanium 2 1.5 GHz (64-bit app/64-bit OS)	3344	204%
AMD Opteron 844 (32-bit app/32-bit OS)	3270	199%
Xeon MP 2.0 GHz (32-bit app/32-bit OS)	1643	100%

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Email Server Performance

MMB2 Performance (2P Servers, Windows®)

AMD
Opteron™
244

11000 112%

Xeon
2.8GHz

9800 100%

Itanium 2 N/A

MMB2 Performance (4P Servers, Windows®)

AMD
Opteron™
844

15520 118%

Xeon MP
2.0GHz

13200 100%

Itanium 2 N/A

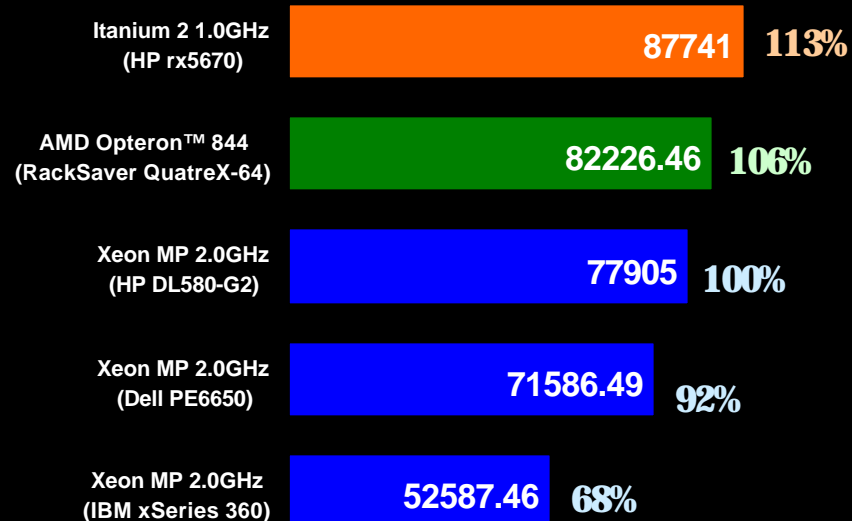
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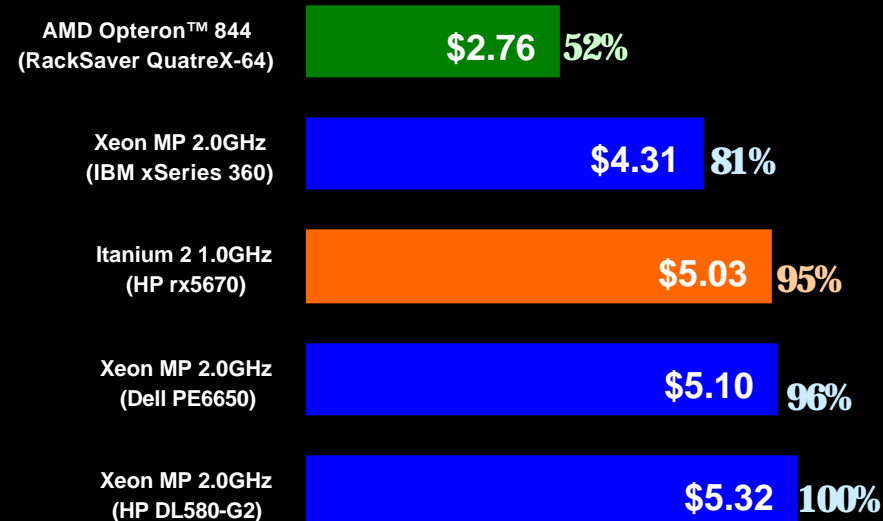


Database Server Performance

TPC-C Performance (4P Servers, tpmC, Windows®)



TPC-C Price/Performance (4P Servers, \$/tpmC, Windows®)



www.amd.com/opteronperformance

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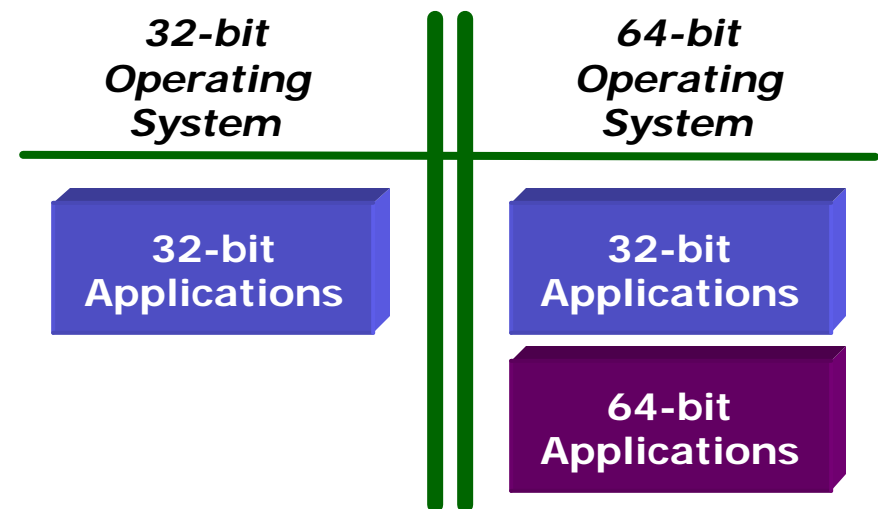
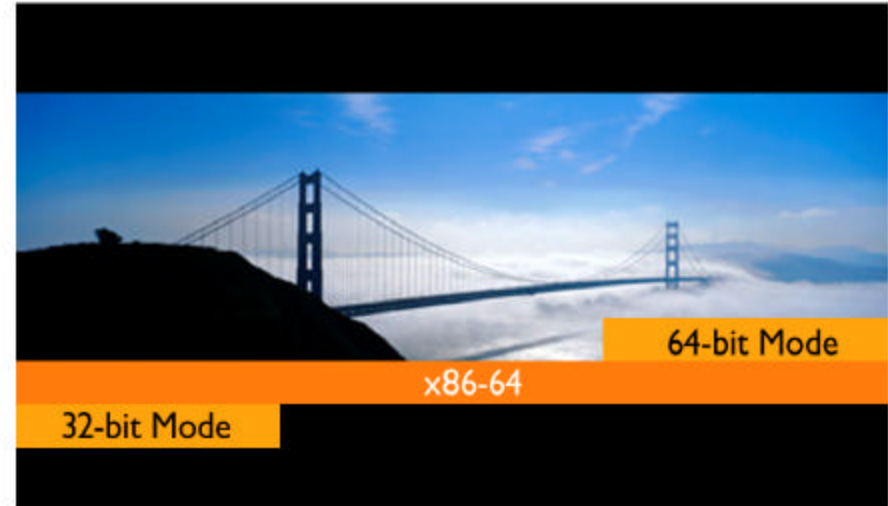
AMD64 Software

AMD Opteron™ and Athlon™ 64

Building a Bridge from the 32 to the 64-bit World



- Provides investment protection for users who have invested in 32-bit application software
- Current 32-bit applications will work on today's 32-bit operating systems as well as tomorrow's 64-bit operating systems
- Enables a gradual application transition to 64-bits as required by end user individual needs.
- Doesn't require special hardware or investment in a proprietary infrastructure



The AMD64 Technology Ecosystem

Operating Systems



Operating Systems	32	64	Comments
Conectiva Linux Enterprise Edition (server)	X		http://www.conectiva.com.br/
Linux Kernel	X	X	http://www.kernel.org - open source kernel
Mandrake Linux 9.0 (desktop/workstation)	X	X	http://ftp.belnet.be/linux/Mandrake/9.0/x86_64/ - free download
Mandrake Linux Corporate Server 2.1 (server)	X	X	http://www.mandrakesoft.com/products/corporate-server
NetBSD UNIX (server)	X	X	http://www.wasabisystems.com - UNIX operating system
Red Hat Linux 9 (desktop)	X		http://www.redhat.com/download/products.html - free download
Red Hat Advanced Server 3.0 (workstation/server)	X	Q403	http://ftp.redhat.com/pub/redhat/linux/beta/taroon/en/as/AMD64/ - beta download
SCO Linux	X		http://www.sco.com/ - Powered by UnitedLinux v1.0
Scyld Beowulf Cluster Operating System	X		http://www.scyld.com/ - Linux-based cluster operating system
Solaris 9 for x86 (server)	X		http://www.sun.com/software/solaris/x86/index.html
SuSE Linux Enterprise Server (SLES) 8 (server)	X	X	http://www.suse.com/us/business/products/server/sles/prices_amd64.html
SuSE Linux 8.2 (desktop/workstation)	X	X	Free download: ftp://mirror.mcs.anl.gov/pub/ftp.suse.com/i386/current/README.FTP
SuSE Linux 8.3 (desktop/workstation)	X	X	To be released with Athlon64 launch
Turbolinux 8 (workstation/server)	X	X	http://cc.turbolinux.com/support/download/ - download preview
UnitedLinux Version 1.0	X	X	http://www.unitedlinux.com/pdfs/UL1_0ProdSpecSheet.pdf
Windows® XP (desktop/workstation)	X	Q403	http://www.microsoft.com
Windows 2000 Server (server)	X		http://www.microsoft.com
Windows Server 2003 (server)	X	Q403	http://www.microsoft.com – 180 day evaluation of 32-bit version

The AMD64 Technology Ecosystem

Announced Device Driver Support



Storage Adapters	Chipsets	Graphics
Promise Silicon Image LSI Logic 3Ware Adaptec	ATI Technologies VIA ALI NVIDIA SIS	NVIDIA ATI Technologies Matrox 3D Labs Trident
Ethernet	Video	Audio
Broadcom National Semiconductor 3Com iReady	Matrox VPG Canopus Linux Media Arts	Creative Labs M-Audio Echo
HPC Interconnects	Infiniband	Fibre Channel
Myricom Dolphin Quadrics	JNI Corporation Infinicon	LSI Logic

**64-bit device
driver support
by industry
leading
hardware
vendors**

Please contact hardware companies for specific schedules and product information

The AMD64 Technology Ecosystem

Additional Targets for Device Driver Support



Storage Adapters	Fibre Channel	Video
QLogic JNI Corporation HP	Emulex QLogic JNI Corporation	Sony Canon Pinnacle
Ethernet	Printer and Imaging	Audio
Realtek Marvell Syskonnect Linksys Netgear	HP Lexmark Epson Canon Fuji-Xerox Brother Ricoh	Realtek Sigmatel SMSC Guillemot Dazzle
Wireless	Gaming Devices	Keyboard and Mouse
Texas Instruments Agere Linksys Netgear	Guillemot Logitech Microsoft	Logitech Wacom Microsoft

**64-bit device
driver support
by industry
leading
hardware
vendors**

Please contact hardware companies for specific schedules and product information

The AMD64 Technology Ecosystem

Development Tools Status



Status of 64-bit Development Tool Support

- Optimized compilers are reaching production quality
- Optimized general purpose math libraries are included with Windows and Linux compilers
- AMD Core Math Libraries (ACML) are available at no charge from AMD and support both Windows and Linux development
- Performance tuning efforts continues

1.8 Mhz AMD Opteron processor – SPECint2000

Compiler	Operating System	Base	Peak
Intel C/C++ 7.0	Windows Server 2003	1095	1170
Intel C/C++ 7.0	Linux/x86-64	1081	1108
Intel C/C++ 7.0	Linux (32-bit)	1062	1100
GCC 3.3 (64-bit)	Linux/x86-64	1045	
GCC 3.3 (32-bit)	Linux/x86-64	980	
GCC 3.3 (32-bit)	Linux (32-bit)	960	

<http://www.aceshardware.com/>

The AMD64 Technology Ecosystem

Development Tools



Analyzers	Win 32	Win 64	Linux 32	Linux 64	Comments
AMD CodeAnalyst 2.1	X	Beta			http://developer.amd.com – download free copy
oprofile			X	X	http://developer.amd.com – download free copy
Vampir/Vampirtrace			X		http://www.pallas.com - MPI performance analysis tool by Pallas GmbH
Compilers	Win 32	Win 64	Linux 32	Linux 64	Comments
Absoft Fortran64				Beta	http://www.absoft.com - native ANSI Fortran 95 compiler Qualified Beta testers can email: opteronbeta@absoft.com
GNU C++ (g++) 3.2 GNU C (gcc) 3.2 GNU Fortran (g77)			X	X	http://gcc.gnu.org/ - open source compilers
GNU C (gcc) 3.3 (optimized)				X	http://gcc.gnu.org/ - open source C compiler
Microsoft® Visual Studio .NET	X	mid-2004			http://msdn.microsoft.com/vstudio/productinfo/ Visual Basic, C, C++, debugger and other tools
Microsoft Visual C, C++		Alpha			Available with Windows for AMD64 alpha release
NAGWare f95 Compiler				X	http://www.nag.com/f95AMD to download a trial copy Supports Fortran 95, High Performance Fortran, and Fortran 77
PGI Cluster Development Kit 5.0	7/21	Planned	7/21	7/21	Toolkit that includes optimized FORTRAN 77/90, C, C++ compilers and tools for cluster application development
PGI Workstation 5.0 (optimized)	X	Planned	X	X	http://www.pgroup.com/ - download 15-day trial FORTRAN 77/90, C, C++ compilers, debuggers PGDBG parallel application debugger; PGPROF parallel app performance profiler

The AMD64 Technology Ecosystem

Development Tools



Debuggers	Win 32	Win 64	Linux 32	Linux 64	Comments
Distributed Debugging Tool (DDT) 1.2.2			X	X	http://www.streamline-computing.com - graphical debugger by Streamline Computing
GNU Debugger (GDB)			X	X	http://gnu.org/ - open source debugger
SoftICE	X	Beta			http://www.compuware.com - device driver debugger by Compuware; contact sheryl.skidmore@compuware.com for beta
TotalView 5.0			X		http://www.etnus.com - distributed debugger by Etnus
Libraries	Win 32	Win 64	Linux 32	Linux 64	Comments
AMD Core Math Library (ACML) 1.0	X	Planned	X	X	http://developer.amd.com - free download Optimized numerical functions (BLAS, LINPACK, FFTs) ported in single-, double-, single-complex and double-complex data types
ATLAS 3.5.0 (optimized)				X	http://math-atlas.sourceforge.net/ BLAS (Basic Linear Algebra Subroutines) library
GOTO Library				X	http://www.cs.utexas.edu/users/flame/goto - High-Performance BLAS by Kazushige Goto (sgemm, dgemm, cgemm, zgemm)
GNU glibc 2.2.5			X	X	http://www.gnu.org/software/libc/libc.html - GNU C Library
GNU glibc 2.3.2 (optimized)				X	http://www.gnu.org/software/libc/libc.html - GNU C Library
MPICH			X	X	http://www-unix.mcs.anl.gov/mpi/mpich Open Source message passing interface for Linux clusters
MPI/Pro (MPI 1.2) Champion/Pro (MPI 2.1) VSI/Pro (math libraries)			Planned	Planned	http://www.mpi-softtech.com - MPI and numeric libraries by Software Technology Inc.
RSA BSAFE Crypto-C, RSA BSAFE Crypto-C Micro Edition				X	http://www.rsasecurity.com/ Encryption library available from RSA Securities

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Development Tools



JAVA	Win 32	Win 64	Linux 32	Linux 64	Comments
Blackdown Java Platform 2 Version 1.4.2			X	Beta	http://www.blackdown.com/java-linux/java2-status/jdk1.4-status.html - SUN Java products ported to Linux by Blackdown group
IBM Java Platform 2 Version 1.3.1	X		X		IBM is formally supporting Linux version on SLES 8 and Windows version when shipped with IBM products.
Other Tools	Win 32	Win 64	Linux 32	Linux 64	Comments
32Direct ; 64Express	X	X	X	X	http://www.migratec.com/MigraTEC/ Cross-platform source code migration technology by MigraTEC
EnFuzion				X	HPC computing management software by Axceleon
LSF 5.1			X		Cluster management software by Platform Computing
Other GNU Tools			X	X	bash, csb, ksb, strace, libtool - included with SuSE SLES 8
PERL, Python, Ruby, Tcl/Tk			X	X	http://www.cpan.org/ - Scripting languages
Vega Prime					Realtime 3D software tools by Multi-gen Paradyn

Worldwide server market(Q2 2003)



- ✓ Linux server platforms generated almost a 40 per cent increase in revenues from the same period a year ago
 - ✓ In terms of units shipped, Linux servers grew 42 per cent
 - ✓ This is **faster growth than any other server-market segment.**
- ✓ The Windows server market also grew - nearly 11.5 per cent
 - ✓ In terms of units shipped, Windows server grew 21.7 per cent
- ✓ The Unix server market a decline of 5.2 per cent

Opteron Processor Ready for 64-bit Linux

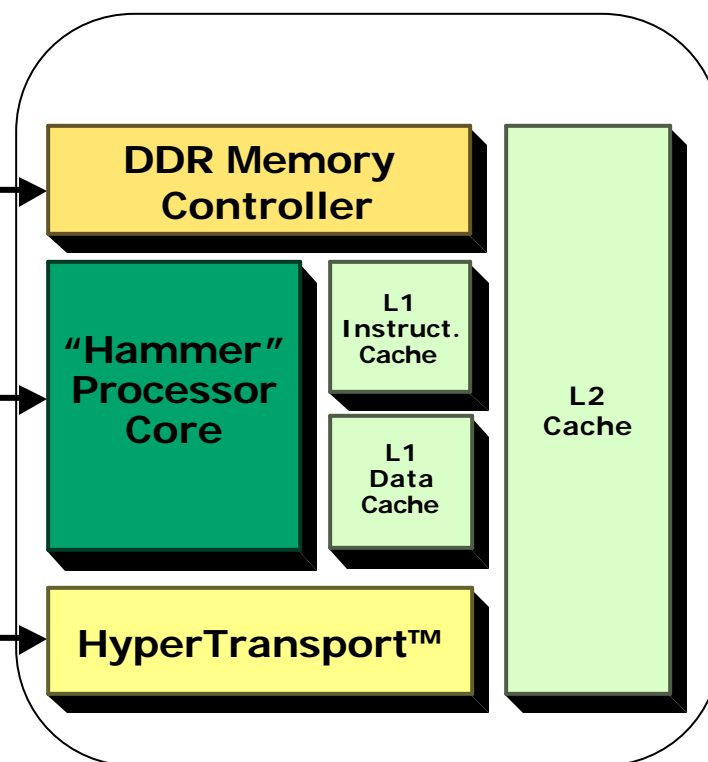


Summary

Remember This!!

- AMD's Opteron architecture integrates key system elements:

- 256Tera byte, 4000 times
- First in the world
32bit & 64bit supporting Processor
- Easy connection to CPU & Chip,
6.4G byte B/W



Thank You



Cautionary Statement



- This presentation contains forward-looking statements, which are made pursuant to the safe harbor provisions of the US Private Securities Litigation Reform Act of 1995. Forward-looking statements are generally preceded by words such as “expects”, “plans”, “believes”, “anticipates”, or “intends”. Investors are cautioned that all forward-looking statements in this presentation involve risks and uncertainties that could cause actual results to differ materially from current expectations. Forward-looking statements in this presentation involve the risk that AMD’s upcoming 8th-generation processors will not be released on schedule, will not gain widespread industry support or market acceptance, and/or global business and economic conditions will worsen resulting in lower than expected demand for servers and, in turn, demand for AMD’s processors for servers. We urge investors to review in detail the risks and uncertainties in the company’s US Securities and Exchange Commission filings, including the most recently filed Form-10K.
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